

**Delaware Department of Transportation**  
**Division of Transportation Solutions**  
**Design Guidance Memorandum**

Memorandum Number 1-6

1. Road Design Manual   2. Bridge Design Manual   3. Utilities Design Manual  
4. Real Estate Manual   5. Standard Specifications   6. Standard Construction Details
- 

Title: Concrete Pavement Rubblization      Effective date: Jan. 1, 2003

Implementation by: X Project Teams, \_\_\_ Bridge, \_\_\_ Team Support, X Specifications,  
\_\_\_ Utility, \_\_\_ Real Estate, X Quality, \_\_\_ DTC, Other M & R

**I. Purpose:**

Use of concrete pavement rubblization as a tool for roadway reconstruction.

**II. Design Guidance:**

Rubblization of PCC pavements is a major rehabilitation technique surpassing, in usage by DOT's, its sister techniques, break and seat (for reinforced concrete pavements) and crack and seat (for plain concrete pavements). Rubblization can be used for plain or reinforced concrete pavements. All three techniques originally were developed to eliminate reflective cracks in asphalt overlay, but rubblization, through its smaller concrete pieces, more effectively eliminates the reflective cracks resulting in a longer lasting pavement. Rubblization is the most expensive among the three (3) initially, however, a selective use of it can be very effective in cost and construction time. DelDOT uses rubblization in lieu of break and seat and crack and seat.

- Rubblization is for total reconstruction.  
Rubblization reduces the structural value of a PCC pavement to a stone base. It requires a thick overlay which may be asphalt or concrete. It is a major reconstruction technique and therefore it should be used only when the pavement has reached the end of its service life, as indicated by the severe deterioration, ASR, or severe freeze and thaw damages, etc.
- Rubblization can be used when other concrete pavement restoration methods will not work.  
The Development Project Leader should thoroughly evaluate the existing condition of PCC pavements. Concrete pavement restoration (CPR) techniques such as diamond grinding, patching or sealing, should be ruled out before the use of rubblization can be specified. Pavement Management and Materials & Research (M&R) should be consulted in the selection of reconstruction/restoration technique.

- Rubblization can not be used over a subgrade demonstrating widespread instability or of poor condition.

Many concrete distresses are a result of poor support conditions at the subgrade. Rubblizing a pavement destroys the concrete slab's bridging action, causing the problems to become more pronounced. The poor support condition could be due to poor soils, poor drainage or high moisture content. If the problem is widespread, rubblization can not be used. Thorough subgrade investigation is essential for the successful application. The designer should contact M&R for subgrade investigation.

- Treat rubblized PCC pavement as a subbase.

Although rubblization provides the benefits of an in-place recycle opportunity and an interlocked stone base, it presents challenges as well. As for all subbase materials, gradation and density are two important factors, but the control of these two factors is more difficult simply because it is in-place recycling.

The pavement breaker may be powerful, but as energy dissipates through the depth of the slab, it is only natural to produce smaller pieces at top and larger pieces at bottom. A soft subgrade or the reinforcement in the slab only compounds the difference in sizes. It is recommended to require the size at the top be 3" maximum and 12" maximum at bottom. Acceptance of a larger size will increase the probability of future reflective cracking. A good density is achieved through the interlocking and good compaction.

With good control on gradation and density, it is reasonable to expect a good fatigue resistance performance of an asphalt overlay, which is a major controlling factor for a flexible pavement service life.

- Rubblization is a balancing act.

The size of rubblized concrete can be controlled. A larger size will provide a stronger support (thus a better structural value), but it increases the likelihood of reflective cracking (thus a reduced service life). The designer needs to balance these two in the pavement design. These guidelines and the Special Provisions are designed to provide a structural value of 0.2 per inch and a relatively free state of reflective cracking. A long term performance evaluation to validate this design value may be necessary.

- Install drainage system.

Adequate subgrade drainage system is essential for rubblization and future performance of the pavement. Rubblization can not be successfully done over a wet subgrade. The drainage system should be in place two weeks minimum prior to the rubblization. In a special case, if the drainage system can not be installed prior to actual rubblization, then a time limit should be specified to have the drainage system installed immediately following rubblization.

- Use a test section, not a second pass of the breaker.  
A second pass over a rubblized area would not enhance the quality of rubblization, and it could cause more damage. We need to do it right the first time. Test sections should be done to calibrate all rubblization variables (machine related-velocity, frequency, pressure or force, shoe size and conditions related-concrete condition or state of distress, thickness and subgrade conditions). The objective is to achieve the required sizes of rubblization both at the top and bottom of the PCC pavement for a good service life.
- Selection of Rubblization Equipments and Production Rates.  
Among the different types of equipment for breaking the pavement, two frequently used types are the resonant pavement breakers (a low impact, low-amplitude, high frequency vibration to the slab) and multiple head breakers (12 to 16 drop hammers mounted laterally in pairs with half of the hammers in a forward row and the remainder diagonally offset in a rear row). The multi-head breaker rubblizes a full lane width in a single pass with a production rate of about one lane mile per shift per day, while a resonant breaker may take up to 20 passes for a full lane width with a production rate of about ½ miles per shift per day.

The designer is cautioned that the multi-head breaker may cause damages to the subgrade and the resonant breaker may produce concrete size too small at the top to meet the design requirement. Unless the equipment selection is specified on the plan, the Special Provision will allow the use of either breaker.

- A concrete overlay can be used.  
Rubblization was originated with the desire to eliminate reflective cracks in the asphalt concrete (AC) overlay, but AC overlay does not have the monopoly. Engineers still have an option of using concrete overlay, with considerations of cost, service and construction time. Please consult M&R for pavement design options.
- Soft spots need to be repaired.  
Original PCC pavement could bridge the soft spot and this soft spot will show up after rubblization. Any depression, one inch or greater in depth from that of the immediate surrounding area, should be examined to see if it is due to poor underlying subgrade before the application of filler aggregate as required by the special provisions. A bearing capacity failure during rubblization could cause depression on one area and heave in other areas.

The repair of soft spots is necessary not only for a long term performance of the pavement but also for a good working platform for paving operations.

- Pavements with delamination type cracks should not be rubblized.  
The presence of horizontal cracks hinders the rubblization process by absorbing energy and decreasing the effective depth of rubblization.

- Survey and set a new profile  
Although rubblization does not significantly change the existing grade, simply specifying a few inches over the existing grade may not be adequate. The existing PCC pavement may not have adequate cross slope, or it is distressed due to poor subgrade which might have resulted in an irregular profile. Comparison of survey results with the original geometry could provide the engineer clues on distress or subgrade conditions.
- The design service life should be 20 years or more and it should be noted on the plans.  
Rubblization with an overlay is a major reconstruction. It should not be used for short-term fix. Use a minimum of 20 year design life as you would use for any other type of major roadway reconstruction.

#### References:

1. AASHTO Guide for Design of Pavement Structures, 1993.
2. Rubblization of Concrete pavements, Transportation Research Record No. 1730, 2000.
3. A Recipe for Rubblization, Road & Bridges, January, 2000.
4. The Rubblization Solution, Better Road, January, 2002.
5. Pavement Rehabilitation, Transportation Research Record No. 1374, 1992.

### III. Justification:

To realize the benefits from proper selection of roadway project using rubblization.

Prepared and	<u>          /s/          Chao H. Hu          </u>	<u>Dec. 2, 2002</u>
Recommended by	Assistant Chief Engineer	Date

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